THE MISSISSIPPIAN ROCKS OF NORTHEASTERN OKLAHOMA[1]

L. C. SNIDER
Norman, Oklahoma

At a recent conference of the state geologists of the states of the Mississippi Valley it was decided to have prepared a brief tabular statement showing the present state of knowledge of the Mississippian rocks in each state, for use of those interested. This tabular statement for Oklahoma has been prepared by the writer. However, such a table is necessarily greatly condensed, and this paper has been prepared to give a somewhat more detailed statement of our present knowledge of these rocks.

The brief outline presented herewith is the result of a rather thorough examination of the literature on the region, and of about five months of field work by the writer, assisted by J. B. Newby. The field work has not been completed, and there are still several points of stratigraphy and correlation on which definite statements cannot be made. The paleontological collections have been studied in only a preliminary way and the faunal lists are necessarily incomplete.

LOCATION AND AREA

The Mississippian area in Northeastern Oklahoma is the southwestward extension of the Ozark Uplift of Missouri and Arkansas. It occupies the extreme northeastern part of the state, including all of Delaware and parts of Ottawa, Craig, Mayes, Wagoner, Cherokee, Adair, and Sequoyah counties. Portions of the Wyandotté, Vinita, Pryor, Siloam Springs, Tahlequah, and Muskogee quadrangles of the United States Geological Survey are included in the area. The region considered, and the relative position of the quadrangles are shown in the sketch map (Fig. 1). The Tahlequah and Muskogee quadrangles were surveyed by Joseph A. Taff for the United States Geological Survey, and the folios

[1] By permission of the Director of the Oklahoma Geological Survey.

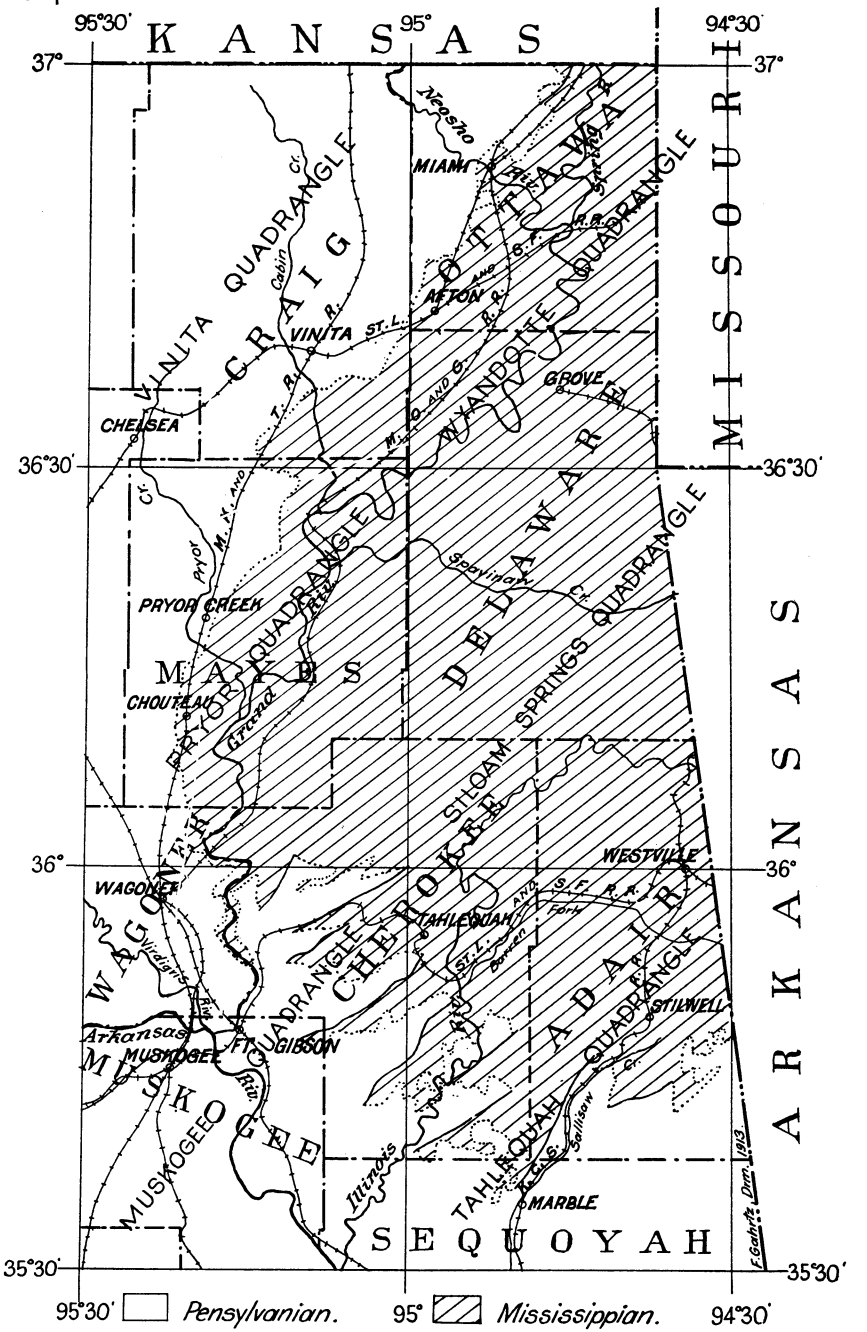

FIG. 1.—Sketch map of a portion of Northeastern Oklahoma showing the Mississippian area.

published several years ago. The Wyandotte quadrangle was surveyed by C. E. Siebenthal in 1907, and the Vinita quadrangle by D. W. Ohern in 1909, but the folios have not been published. The references to the geology of the Tahlequah and Muskogee quadrangles are to be attributed to the folios (Nos. 122 and 132 respectively) of the *Geologic Atlas of the United States*, prepared by Joseph A. Taff. It is not thought necessary to give footnotes for the individual references.

STRATIGRAPHY AND PALEONTOLOGY

The Mississippian rocks of Northeastern Oklahoma comprise the following formations named from the base up: Boone formation, unnamed limestone, Fayetteville shale, and Pitkin limestone. The stratigraphy of all these formations varies considerably as the outcrops are followed west from the Arkansas line along the south side of the area and then north along the west side.

Boone formation.—The Boone formation covers by far the greater part of the area under consideration. In the Tahlequah and Siloam Springs quadrangles some of the deeper valleys are cut through the Boone into the underlying Devonian, Silurian, and Ordovician rocks, but the outcrops of these rocks are narrow and the Boone covers all the area indicated, except a comparatively narrow belt around the margin, which is occupied by the younger formations, and the outliers of these formations.

The Boone consists principally of limestone and chert, with a total thickness of from 100 to 350 feet. At or near the base of the formation there is locally a limestone member of up to 30 feet or even more in thickness. The upper part of this limestone is free from chert, thick-bedded, light-colored, and crinoidal. Near the Arkansas line, in the Tahlequah quadrangle, the limestone is locally absent so that the cherts rest directly on the Chattanooga shale. In no place in this quadrangle is the limestone reported as being over 15 feet in thickness. This thickness is exceeded in the Siloam Springs quadrangle, and the limestone is continuous to the northwest so far as observed. In the northern part of the area there are several feet of shaly limestone and flaggy limestone below the thick, crinoidal ledge which in this region is 10 to 15 feet thick.

This lower limestone member is correlated with the St. Joe limestone (marble) member of the Boone formation in Arkansas. It is well exposed in the Siloam Springs quadrangle along the Illinois River and some of its tributaries, along Spavinaw Creek in the Siloam Springs and Pryor quadrangles, and along the larger tributaries of Grand (Neosho) River in the Vinita and Wyandotte quadrangles. From collections made along the Illinois River in the Siloam Springs quadrangle, the following brachiopods have been identified: *Rhipidomella michelinia* L'Eveille, *Chonetes logani* N. and P., *Productus fernglenensis* Weller, *P. sampsoni* Weller, *P. sp.*, *Spirifer grimesi* Hall, *S. vernonensis* Swallow, *S. fernglenensis* Weller, *S. choteauensis* Weller, *Spiriferina subtexta* White, *Cyrtina burlingtonensis* Rowley, *Reticularia pseudolineata* Hall (?), *Cleiothyris royssi* L'Eveille (?), *Athyris lamellosa* L'Eveille, and *Ptychospira sexplicata* W. and W. The remainder of the fauna has not been studied, but the corals and some of the bryozoa appear to be identical with those described by Weller[1] from the Fern Glen formation, and which occur in the lower beds described in the next paragraph.

Locally there are darker-colored limestones with greenish shales below the St. Joe member. Taff describes these as occurring in one outcrop near the northern border of the Tahlequah quadrangle, where they have a thickness of 6 feet. A few miles to the north in the Siloam Springs quadrangle these same dark-colored limestones and green shales reach a thickness of about 40 feet, but they vary greatly in thickness in very short distances. The fauna of these rocks shows them to be equivalent to the Fern Glen formation of Missouri. To the northwest these rocks thin rapidly and in the northeastern part of the Pryor quadrangle along Spavinaw Creek, and in the southeastern part of the Vinita quadrangle along Big Cabin Creek there is only a layer of soft green clay shale, less than a foot thick, between the Chattanooga shale, and the St. Joe member of the Boone. Although no fossils have been found in this shale layer, it is believed to represent the Fern Glen on account of its character and position.

[1] Stuart Weller "Kinderhook Faunal Studies," V, The Fauna of the Fern Glen Formation, *Bull. G. S. A.* xx, 265–332.

The following species have been identified from the Fern Glen horizon in the Siloam Springs quadrangle: *Cyathaxonia arcuata* Weller, *C. minor* Weller, *Cladochonus americanus* Weller, *Amplexus brevis* Weller, *Fistulipora fernglenensis* Weller, *Cystodictya cf. lineata* Ulrich, *Actinocrinus rubra* Weller, *Rhipidomella michelinia* L'Eveille, *Schizophoria swallovi* Hall, *Productus fernglenensis* Weller, *P. sampsoni* Weller, *P. sp.*, *Camarotoechia persinuata* Winchell, *Spirifer vernonensis* Swallow, *S. fernglenensis* Weller, *S. grimesi* Hall, *S. choteauensis* Weller, *Spiriferina subtexta* White, *Athyris lamellosa* L'Eveille, *Cleiothyris prouti* Swallow, *C. royssi* L'Eveille, and *Platyceras paralius* W. and W. There are also several unidentified species of bryozoa, principally fenestellids. The *Productus* listed as *P. sp.* is a large species known to occur also in the Chouteau limestone of Missouri.

The greater portion of the Boone consists of limestone and chert. In most of the good exposures observed by the writer, the limestone and chert occur in alternate layers averaging about one to two feet in thickness. In many cases, however, the chert is distributed irregularly through the limestone as lenses and nodules. The cherts are often fossiliferous but practically no work has been done on the paleontology of the Boone in Oklahoma. In the Muskogee and Tahlequah folios Taff lists the following species from the cherts in the upper part of the formation: *Amplexus fragilis* White and St. John, *Glyptopora keyserlingi* Prout, *Fenestella multispinosa* Ulrich, *Polypora maccoyana* Ulrich, *Hemitrypa proutana* Ulrich, *Pinnatopora striata* Ulrich, *Spirifer logani* Hall, *Reticularia pseudolineata* Hall, *Productus setigerus* Hall, *Derbya keokuk* Hall, and *Capulus equilaterus* Hall. In a small collection from a few miles east of the town of Pryor Creek in the Pryor quadrangle the writer has noted *Productus setigerus*, *Spirifer logani*, and *Derbya keokuk*. This fauna is decidedly indicative of Keokuk age.

In general it may be said that there are no strata in the Boone in Oklahoma which permit the formation to be divided into members. In the Joplin district in Missouri, Siebenthal[1] distinguishes the Grand Falls chert and Short Creek oolite members. In the

[1] C. E. Siebenthal, Joplin District folio (No. 148), *Geologic Atlas of the United States, U.S. Geol. Survey*, 1907.

paper on the Mineral Resources of Northeastern Oklahoma[1] the same author describes the Short Creek oolite as being present in the eastern half of the Wyandotte quadrangle but does not mention the Grand Falls chert member. The extension of these members to the southwest is problematic.

As has been said the fauna of the Boone indicates the great mass of it to be of Burlington-Keokuk age. It has been reported[2] to the writer that fossils suggestive of Warsaw age have been found above the Short Creek oolite in Missouri. No collections from this horizon in Oklahoma have been studied and the exact age of the upper beds of the Boone formation in the State must be considered an open question as yet.

Unnamed limestone.—The upper limit of the Boone formation is one of unconformity. If the upper part of the cherts of the Boone are of Keokuk age, the time interval represented by the unconformity includes all of Warsaw, Salem, St. Louis, and Ste. Genevieve time. It is possible that more detailed work in the Boone area may prove some of the lower of these formations to be present, but so far as is known now they are absent.

Immediately above the cherts of the Boone in the Tahlequah quadrangle come a few feet of limestone which in this quadrangle were mapped with the Boone. In the Muskogee quadrangle, this limestone was found to be somewhat thicker and to be separated, at least locally, from the Boone by a thin layer of shale. The fossils proved the shale and limestone to be of Chester age, so they were considered as part of the overlying Fayetteville shale. North from the Muskogee, through the Pryor quadrangle this limestone thickens very rapidly until it attains a thickness of 90 or 100 feet along Grand (Neosho) River east of Choteau and Pryor Creek. In the Pryor quadrangle these rocks can be easily mapped and must be regarded as a formation. In view of the fact that this formation has been studied in the Vinita quadrangle, and that it will probably be named in the reports of the United States Geological Survey, no name is proposed here. This formation includes all the rocks between the Boone chert and the typical

[1] *Bull. U. S. Geol. Survey No. 340.*

[2] Personal communication from H. A. Buehler.

black clay shale of the Fayetteville shale. The correlation of these rocks to the north of the Pryor quadrangle is yet in doubt. They seem to keep the same general characteristics across the corner of the Vinita quadrangle that they have in the Pryor. In the Wyandotte quadrangle, however, there is considerable sandstone in the lower part of the Fayetteville shale, or below it, which Siebenthal[1] calls the Batesville sandstone. On a sketch map of the Pryor quadrangle sent the writer he uses the field term, sub-Batesville limestone, and it is understood that the same term was used in the Wyandotte quadrangle. Since the Batesville sandstone of Arkansas does not extend into Oklahoma on the south side of the uplift, it does not seem that the name can be used in the Wyandotte quadrangle, although the sandstone there occupies practically the same stratigraphic position as the typical Batesville. Siebenthal's sub-Batesville limestone is almost certainly the northward continuation of the unnamed Chester limestone formation of this paper, and the sandstone called Batesville may also belong to it.

The fauna of these limestones between the Boone and Fayetteville formations, so far as the collections have been studied, is as follows: *Productella hirsutiformis* Walcott, *Productus pileiformis* McChesney, *P. cestriensis* Worthen, *P. inflatus var. coloradoensis* Girty (?), *Liorhynchus carboniferum* Girty, *Camarotoechia purduei* Girty, *Moorefieldella eurekensis* Walcott, *Spirifer increbescens* Hall, *Reticularia setigera* Hall, *Seminula subquadrata* Hall, *Derbya keokuk* Hall, *Eumetria marcyi* Shumard, and *Deltopecten batesvillensis* Weller. There are also several species of bryozoa in the upper part and of pelecypods in the lower part of the formation that have not yet been identified. One layer of arenaceous and calcareous shale near the base is marked by a large trilobite. The fauna has, however, been determined with sufficient completeness to correlate these limestones with some degree of certainty with the Spring Creek limestone and the Moorefield shale and possibly with the Batesville sandstone of Arkansas.

The unconformity between this limestone and the underlying Boone chert has already been noticed. In the Tahlequah and

[1]C. E. Siebenthal, "Mineral Resources of Northeastern Oklahoma," *Bull. U.S. Geol. Survey No. 340*, p. 190, 1908.

Muskogee quadrangles this unconformity is not very striking as is shown by the mapping of the Chester limestone in the Tahlequah with the underlying Boone and by its separation from the Boone in the Muskogee only on account of the fauna and the thin layer of shale at the base of the limestone. In the Pryor quadrangle, however, this unconformity is very pronounced and the hills of typical Boone chert protrude through the limestone in several places, and in at least one place (hill just east of the town of Pryor Creek) through a considerable portion of the Fayetteville shale. The tops of some of the hills of Boone chert are at approximately the same level as the tops of other hills in the vicinity which are capped by the Pitkin limestone. The conditions are represented

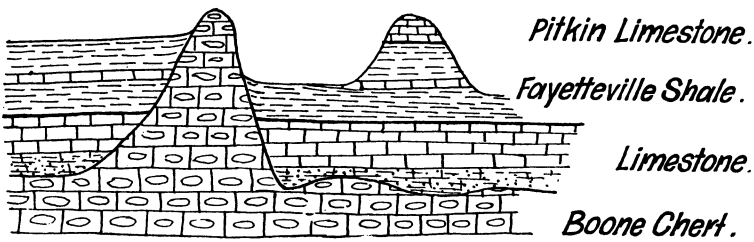

FIG. 2.—Diagram illustrating unconformity at top of Boone formation in the Pryor quadrangle.

diagrammatically in Fig. 2. When these hills were first observed they were thought to be structural domes but more careful work has shown that the limestones and Fayetteville shale lie up against the chert in a horizontal position so that the presence of a pronounced unconformity seems to be the only hypothesis which accounts for the hills of chert above the level of the unnamed limestone and the Fayetteville.

Fayetteville shale.—Near the Arkansas line in the Tahlequah quadrangle the Fayetteville shale is reported as reaching a thickness of 120 feet, but in the Muskogee quadrangle it is said by Taff not to exceed 60 feet. In a section measured southeast of Ft. Gibson by Ohern and the writer, however, the Fayetteville shows a thickness of about 100 feet. The formation consists principally of blue to black, fissile clay shales with thin limestones, usually lenticular. In the Tahlequah quadrangle there is a sandstone

member, the Wedington, which reaches a thickness of 40 feet. It thins out to the west and disappears about the middle of the quadrangle. In the Pryor quadrangle, the Fayetteville has the same general characteristics as to the south in the Muskogee quadrangle. The limestones thicken somewhat to the north, and are more persistent while the formation as a whole thins considerably. On the bluff of Grand River southeast of Choteau, the thickness is 90 feet. The basal 18 feet are composed of alternating layers of black shale and blue, dense limestone averaging about 6 inches in thickness. The limestone has a conchoidal fracture, is non-fossiliferous and weathers to a very light gray color. About the middle of the formation is a bed of limestone 12 feet thick, of which some layers are composed in large part of the shells of *Productus pileiformis* and *P. cestriensis*. This limestone is persistent for some miles to the north. So great a thickness has not been observed elsewhere, but this may be due to the poorer exposures.

The following species were collected from the limestones of the Fayetteville about 4 miles southeast of Ft. Gibson in the Muskogee quadrangle: *Lingulidiscina sp.*, *Productella cf. hirsutiformis* Walcott, *Productus sp.*, *P. pileiformis* McChesney, *P. cestriensis* Worthen, *P. cf. inflatus var. coloradoensis* Girty(?), *P. cf. subsulcatus* Girty, *Moorefieldella eurekensis* Walcott, *Spirifer arkansanus* Girty, *S. increbescens* Hall, *Martinia glabra* Martin(?), *Spiriferina sp.*, *Camarophoria sp.*, *Reticularia setigera* Hall, *Seminula subquadrata* Hall, and *Eumetria marcyi* Shumard. The following additional species are listed by Taff in the Muskogee folio: *Septopora cestriensis* Prout, *Archimedes compactus* Ulrich, *A. communis* Ulrich, *A. intermedius* Ulrich, *A. swallovanus* Hall, *Polypora corticosa* Ulrich, *Spiriferina spinosa* N. and P.

To the north, in the southeastern corner of the Vinita quadrangle, it is necessary to consider the Fayetteville and Pitkin horizons together. The section of the Mississippian rocks above the Boone chert in this vicinity is made up of four limestones and three shales. The lowest limestone is the unnamed limestone at the top of the Boone which has been considered. The topmost limestone is about 15 feet thick, and is probably the Pitkin limestone, although there is some doubt as to this correlation. The

other two limestones are thin, not over 5 feet in thickness. They and the shale between them are very fossiliferous, bryozoa being especially abundant. Exceptionally well-preserved shells of *Productus*, and *Chonetes* as well as screws of *Archimedes* and specimens of other bryozoa weather from the shale in abundance. The *Productus* is the species which is doubtfully identified with *P. inflatus var. coloradoensis* Girty, in previous lists in this paper. The *Chonetes* is a rather large, flat species which is apparently unnamed. Specimens of the same species from Arkansas are in the University of Chicago collection.

In addition to these forms the following species have been identified from the two lower limestones: *Lioclema gracillimum* Ulrich, *Fenestella cestriensis* Ulrich, *F. serratula* Ulrich, *Streblotrypa nicklesi* Ulrich, *S. distincta* Ulrich, *S. major* Ulrich, *Stenopora tuberculata* Prout, *Polypora cestriensis* Ulrich, *Pinnatopora vinei* Ulrich(?), *Pinnatopora sp.*, *Cystodictya nitida* Ulrich, *C. cf. lineata* Ulrich, *Thamniscus furcillatus* Ulrich, *Productus cestriensis* Worthen, *Spirifer increbescens* Hall, and *Spiriferina transversa* McChesney.

Pitkin limestone.—In the Tahlequah quadrangle the Pitkin limestone varies in thickness from about 5 feet to 70 feet. In character it varies from an impure, shaly limestone to a massive blue, crystalline limestone. In the Muskogee quadrangle the thickness of the Pitkin varies little from 50 feet. The formation in this quadrangle consists of light blue to brown, granular, earthy, slightly oolitic strata interbedded with fine textured massive layers. The individual beds vary from thin, platy layers, often separated by thin shale partings, to massive layers 2 feet in thickness. In this quadrangle the Pitkin is apparently perfectly conformable above the Fayetteville and below the Morrow formation of Pennsylvanian age. Indeed, the line between the Pitkin and the Morrow is very difficult to follow, and the separation is usually made on the basis of fossils. From the Muskogee quadrangle north, the Pitkin thins very rapidly and also changes in physical characteristics. The massive, pure limestone phase disappears and the formation becomes argillaceous and ferruginous. Locally the limestone is very sandy. In these localities the beds are thick, and on weathering show intricate cross bedding. Where there

is little sand in the formation the limestone is thin bedded and platy. The surfaces of the thin plates are usually covered by fossils in a more or less weathered condition; bryozoa are particularly abundant but are commonly poorly preserved.

The thickness of the Pitkin in the Pryor quadrangle is seldom over 20 feet and is usually less. From the middle of the quadrangle northward the Pitkin is locally absent, and the sandstones of the Pennsylvanian lie upon the shale of the Fayetteville, or in some places, upon the limestone about the middle of that formation. In such cases the basal portion of the Pennsylvanian sandstone is conglomeratic, containing pebbles of limestone up to an inch or more in diameter. The Mississippian-Pennsylvanian unconformity is thus very noticeable in the Pryor quadrangle, although it is not evident in the quadrangle to the southward. As noted in a previous paragraph, the correlation of the Pitkin in the Vinita quadrangle is in doubt. The topmost of the four limestones in this vicinity is probably the Pitkin. In the paper previously mentioned Siebenthal refers to the Pitkin as being present in the Wyandotte quadrangle, but gives no details concerning it. The section, however, is known to be very similar to that of the Vinita quadrangle.

The fauna of the Pitkin is very similar to that of the limestones of the Fayetteville. *Archimedes* is very abundant and the limestone was called the Archimedes limestone in the older reports of the Arkansas survey. The bryozoa which occur so abundantly in the formation in the Pryor quadrangle have not been studied as yet. The fauna is undoubtedly very similar to that already listed from the Chester limestones in the Vinita quadrangle, which may be in part from the Pitkin horizon.

SUMMARY

The Mississippian area in Northeastern Oklahoma is continuous with the Ozark region of Missouri and Arkansas. The section includes the Boone formation, unnamed limestone of Chester age, Fayetteville shale, and Pitkin limestone. The Boone formation and chert is from 100 to 350 feet thick and ranges in age from Kinderhook to Keokuk. The Kinderhook is represented by shale

and limestone occurring locally at the base of the formation which are correlated with the Fern Glen formation of Missouri and Illinois. The great portion of the Boone is of Burlington-Keokuk age. The Warsaw, Salem, and Ste. Genevieve are supposed to be absent, the formations above the Boone being of Chester age. At the base of the Chester is a formation consisting principally of limestone which is very thin along the southern part of the area, but thickens to at least 100 feet along the western side, where the unconformity between it and the Boone is very marked. The Fayetteville shale thins from the Arkansas line westward and northward. The sandstone member (Wedington) disappears and limestones become more important. The Pitkin limestone thickens and becomes more regular in thickness westward from the Arkansas line into the Muskogee quadrangle, and then thins rapidly and becomes argillaceous and ferruginous to the northward. In the Pryor and Vinita quadrangles it was locally removed by erosion before the deposition of the overlying Pennsylvanian rocks.

It should be repeated that the work on these rocks is still in progress and that this paper is merely a statement of the facts concerning them so far as they are known at present. The faunal lists given are admittedly very incomplete, their aim being to list only the better known or more abundant species.